Spring 2021

ME 407-102: Heat Transfer

TianQi Hang

ME 407-102/ Heat Transfer (2021 Spring)

Instructor: Dr. TianQi Hang
Email: th43@njit.edu
Class meeting time: Tuesday 06:00 PM - 08:50 PM
Office hour : by appointment

IMPORTANT NOTICE FOR THIS SEMESTER:
Check your email and Canvas regularly, as frequent as possible.

Objective: To understand the basic heat transfer modes and apply the heat transfer relations for the analysis of heating and cooling energy systems or thermal systems.

Pre-requisite: Math 222 – Differential Equations (PDE) or equivalent,
ME 304 – Fluid Mechanics,
ME 311 – Thermodynamics I

Required Textbooks and related materials

Incropera and DeWitt, An Introduction to Heat Transfer, 6th edition. John Wiley & Sons 2011, or equivalent.
Important dates in Spring 2021 academic calendar
https://www5.njit.edu/registrar/calendars/

Week		Contents
1	1/19	Heat transfer course introduction, syllabus, project guideline. Ch1: Intro to HTR Ch1: Intro to HTR (conduction, convection, radiation) (Thermodynamics)
2	1/26	Ch2: Intro to conduction (Fourier's Law, Diffusion equation) Ch2: Intro to conduction (transient behavior). Ch3: 1-D plane wall
3	2/2	Ch3: 1-D steady state Cond.- radial system w/o heat generation. Heat Generation. Ch3: 1-D steady state cond. – heat generation system. Fin analysis.
4	2/9	Ch3: 1-D steady state cond. – fin analysis Ch4: 2-D steady state cond.- SoV; shape factor
5	2/16	Ch4: 2-D steady state cond.- finite difference method Ch5: Transient Cond. – lumped capacitance method **(Quiz #1)**
6	2/23	Ch5: Transient Cond. – one term approximation; semi-infinite solid Ch5: Transient Cond. – finite difference method (explicit, implicit)
7	3/2	Ch5: Transient Cond. – finite difference method (explicit, implicit) Ch6: Intro to Conv. – Boundary Layer, conv coefficient
8	3/9	Ch6: Intro to Conv. –Non-dim parameters and Reynolds Analogy **Midterm #1 (Conduction Ch1-5)**
9	3/23	Review and Ch7: Flat plate introduction Ch7: External flow – Flat plate in parallel flow
10	3/30	Ch7: External flow – Cylinder in cross flow, Sphere & Ch8: Internal flow –fully developed analysis: hydrodynamics & thermal Ch8: Internal flow –fully develop, constant T & constant heat flux analysis
11	4/6	Ch8: Internal flow- heat transfer correlations, entry length effect Ch9: Free convection – laminar BL, Boussinesq approx., similarity, & Ch10. Pool boiling, film boiling, film condensation
12	4/13	Ch11. HEX- parallel and counter flow analysis, LMTD method **(Quiz #2)** Ch11. HEX- Effectiveness-NTU method
13	4/20	Ch12. Radiation, Opaque & Blackbody, Wien's Displ. law, S-B law, Real surface, Kirchhoff's law Ch13. View factor
14	4/27	Ch13. Radiation exchange: blackbody, opaque Ch13. Radiation exchange: gray body. Review

15	TBD	**Final Exam (Convection – Radiation)**

* This schedule is subject to change during the actual running of the semester.

Grading Policies (Honor section will be separately graded from Regular section.)

(1) Grading (total 100): Grading Scale: A (>90), B+ (>85), B (>80), C+(>75), C (>70), D+ (>75), D (>60) & F (< 60)

- Homework (10)
- Two Quizzes (20)
- Midterm (30)
- Final (30)
- Project (10)

Note-1: "NO EXAM" goes to ZERO point.
(except only for the **instructor-approved** & **officially documented emergency** accident/medical excuse from the Dean of Students)
Note-2: There will be NO makeup test in this class.

Homework:

- HWs are **due at the start of the class** on the due date.
- HW must be scanned and uploaded to the corresponding Canvas link
- No late submission accepted.
- **20% discount** if **not follow** each guideline.
- **Each problem MUST start on a new page**. Don't put multiple problems on one page.
- **Each problem should have the following sections**:
  i. Known: A summary of the problem, "in your own words".
  ii. Find: Quantities to be determined.
  iii. Schematic: Sketch the physical system
  iv. Assumptions: Assumptions to be used in solving the problem are listed.
  v. Properties: Material properties needed, values and sources.
  vi. Analysis: Solve a problem in a systematic and logical manner, **showing all steps**.
  Final Answers MUST be clearly indicated with a box.

(2) **Final project:** guideline (see the details on the guideline in **S2. Final Project Guideline**)

- **2~3 members/team (Coordinator/Checker, Recorder)**
- Real life heat transfer problem: problem description, model development, analysis, BCs, ICs, etc
- Project progress meeting (Mandatory) with professor after Midterm. See the details for **S3. Project Progress Meeting Guideline** in the following pages.

(3) Exam Requirements

- **Quizzes:** **Open note (your own hand-written lecture note only).**
- **Midterm/Final:** **Open note (your own hand-written lecture note only).**
- Simple Calculator (No programmable calculator). No share of calculator.
- No tele-communication tools, such as cell phone, lab-top, smart watch, etc.

**** S4. **NJIT Honor Code – Strictly Enforced****

http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf.

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NJIT Canvas **https://njit.instructure.com/courses** (UCID login required)

- Check and update your contact email address in Canvas. Everything will be emailed through it.
- Every notice, change and exam information will be posted on Canvas and/or email.
- HWs will be posted and emailed through Canvas.

S1: HW Submission Guideline

- Encourage team discussion for HW problems to understand all the problems.
- Each HW will be posted on Canvas and/or email to students with due date and emailed by the Canvas. system to your NJIT email address registered in Canvas. system.

- HW MUST be scanned and uploaded

S2. Final Project Guideline

A. Team Size and Role

* Standard size of team is **2-3 students**. (Different size of team is NOT acceptable WITHOUT APPROVAL.)
* Formulate your team by yourself with your choices and preferences

* Team role recommended: Coordinator, Checker, Recorder
  - **Coordinator**: team meeting coordination, meeting date/time/place coordination, meeting agenda coordination. Keep moving the project. etc. Keep everyone on task and get involved.
  - **Recorder**: meeting recording/minutes, sharing the meeting outcomes, etc. Final project submission.
  - **Checker**: project progress check and update, sharing the status of the project, etc. Final report guideline check. Final project submission double check.
* Optional Team member evaluation form may be submitted individually after the project submission. (by individual emails)

B. Scope of Project Problem

1. You need to create your own problems from our real life systems. For example, engine, engine cooling radiator, boiler, computer chip cooling, swimming suit, satellite, jet engine, etc
2. More creative problem is preferred.
3. Conduction, convention and radiation- mixed problem is preferred. or the problem with at least two of heat transfer mode mixed is preferred.

C. Standard Report Guideline (Final project page limit: 15 pages)

General section:

1. cover page: course name, project team members and roles, project title, submission date, etc
2. abstract (~ 0.5 pg)
3. role description of each team member in the project activities and developments (~ 0.5 pg).
4. table of contents (~ 1 pg)

Technical Narrative sections:

5. motivation, objectives, etc (~ 1 pg)
6. introduction and background of the problem, (~ 2-3 pg)
7. model development, model geometry, assumptions, etc: detail descriptions (2- 3 pg)
8. theory: detailed explanations of the thermal or heat transfer theory applied to the problems. (2-3 pg)
9. Analysis: analytical or computational analysis, explanations of computational approaches, etc (2-4 pg)
10. Results and discussion: Not only showing figures, graphs, but also explaining them, etc (2-3 pg) and more of your choices for better project report.
    - All the page numbers are only for recommended suggestions, not for a limit.

References and Appendix: (No limit. Below are not included in the page limit of 15.)

A. references
B. Appendix if any (Any materials that are not included in the body section due to the page limit can be attached.)

D. Writing Format Guideline

* **Page limit: maximum 15 pages** including all the figures and tables in technical narrative sections from motivation to the end of results and discussion. Cover/Table of contents, References and Appendix are not counted in this 15-page limit.

* Format:
  - **Letter size,**
  - **1-inch margin,**
  - **Font size 11 for body text, (Bigger font for heading is OK.)**
  - **Times New Roman or Arial font,**
  - **Single-spaced line.**
  - (Bigger font size for title/outline/heading is acceptable.).
  - Bold or italic font are also acceptable for outlines or highlights.

* **Plagiarism check (from other project reports, web sources, book sources, etc) will be performed: Honor Code strictly reinforced.**

E. Evaluation

- Final project evaluation guideline:

General section: (10%) – Not counted in the 15-page limit

1. cover page: course name, project team members and roles, project title, submission date, etc
2. abstract
3. role description of each team member in the project activities and developments
4. table of contents

Technical Narrative sections: (80%) – (15-page limit)

5. motivation, objectives, etc (~ 10%)
6. introduction or background of the problem, (~ 10%)
7. model development, model geometry, assumptions, etc: detail descriptions (~ 10%)
8. theory: detailed explanations of the thermal or heat transfer theory applied to the problems. (~ 20%)
9. Analysis: analytical or computational analysis, explanations of computational approaches, etc (~20%)
10. Results and discussion: Not only showing figures, graphs, but also explaining them, etc (~10%)

* Note-1: The percentage of each individual section above is a suggested example, but the percentages may be subject to the development of the contents of final project outcomes.

References and Appendix: (10%) – Not counted in the 15-page limit.

A. references

B. Appendix if any (Any materials that are not included in the body section due to the page limit can be attached.)

Example evaluation:

90%: strong background study, model develop, model analysis, in-depth analysis, conv/cond/rad mix-up problem,
80%: fairly good, may be a typical problem, may have some weak analysis, or results is generally good,
70%: weak at some sections, typical problem, weak analysis,
60%: very weak, overall, poor analysis/result/discussion, overall contents NOT complete,

*Note-2: 20% discount if not follow the guideline on writing format, page limit, or late submission.

F. Submission Format and Due Date

* **MS word & pdf** format, **both** format of file MUST be **submitted**.
* Final project due date: April 19, 2021 End of Day by **Canvas**.

S4. NJIT Honor Code

NJIT Honor Code is strictly enforced over the course of all the activities including HWs, EXAMs and Projects.

****** NJIT Honor Code – Strictly Enforced******

http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf.

"Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at:

http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf.

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu"